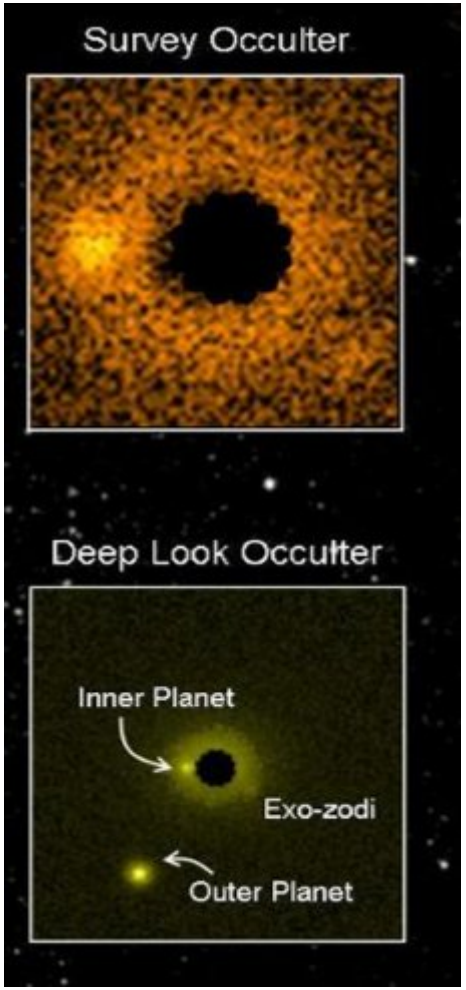
Exoplanet Imaging SAG

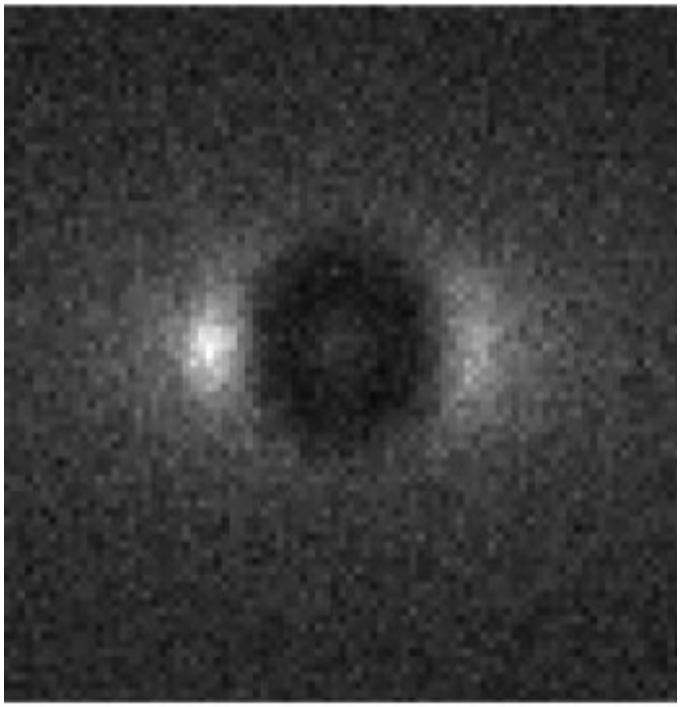


Solar systems as seen by NWO mission (Arenberg 2006)

2nd Meeting: Progress Report

ExoPAG

June 1, 2011
Alexandria, VA



Nearby Earth in 1 zodi disk near 2λ/D (Guyon et al. 2009)

T. Greene
NASA Ames
tom.greene@nasa.gov

Revised Task

- NASA (D. Hudgins) announced new strategy toward Exoplanet imaging mission selection @ Jan ExoPAG:
  - ExoPAG sets science requirements by early 2012
  - Mission concept studies solicited; awarded by 2013
  - Mission architecture chosen by 2015
- Coronagraph and Occulter SAGs were combined after Jan ExoPAG meeting
- The combined SAG is to focus on science requirements for the 2020+ imaging mission by 2012
  - Instrumentation, Technology and DRM components removed from task (but still important for decision - we still need the expertise of those people in this SAG)

Imaging SAG Membership

- C. Noecker & T. Greene are co-chairs
- ~ 45 scientists, technologists, engineers: welcome!

L name	F name	email	Institution	Interests / Expertise	SAG Task area
Apai	Daniel	apai@as.arizona.edu	UA	Ground-based imaging searches / characterization	
Augereau	Jean-Charles	augereau@obs.ujf-grenoble.fr	IPAG Grenoble	debris disks and exozodiacal dust disks, SPICES concept	dust, planet imaging
Belikov	Rus	ruslan.belikov-1@nasa.gov	NASA ARC	coronagraph technology	
Breckinridge	Jim	jbreckin@caltech.edu	CIT (adjunct)	Planet imaging telescopes and technologies	
Cahoy	Kerri	kerri.cahoy@gmail.com	MIT / NASA GSF	Planetary atmospheres, mission design, DRMs	Science, DRM, mission trades
Cash	Webster	wcash@origins.colorado.edu	Univ Colorado	Science measurements, DRMs, occulters, technology	occulter
Clampin	Mark	mark.clampin-1@nasa.gov	NASA GSFC	coronagraph science and technology (VNC)	coronagraph
Defrere	Denis	ddefrere@mpifr-bonn.mpg.de	MPIfR Bonn	Imaging exozodiacal disk structures in Hzs and impact on planet imaging	Science
Glassman	Tiffany	Tiffany.Glassman@ngc.com	Northrop Grumm	Starshades / science requirements	occulter
Greene	Tom	tom.greene@nasa.gov	NASA ARC	observations, technology, DRM	editor and co-chair
Guyon	Olivier	guyon@naoj.org	UA / Subaru	coronagraph science and technology (PIAA)	coronagraph
Kaltenegger	Lisa	lkaltene@cfa.harvard.edu	CfA /MPIA	Earth-like atmospheric spectra	Science
Kasdin	Jeremy	jkasdin@Princeton.EDU	Princeton	coronagraphs, occulters, system engineering	occulter and coronagraph
Krist	John	john.krist@jpl.nasa.gov	JPL	coronagraph design & modelling, debris disk imaging	Modeling requirements, post-observation reduction
Levine	Marie	marie.b.levine-west@jpl.nasa.gov	JPL	Technology, observatory system design, requirements & analysis	system engineering
Lilly	Chuck	chuck.lillie@ngc.com	Northrop Grumm	Architecture issues, technology	Occulter & coronagraph
Lisman	Doug	p.d.lisman@jpl.nasa.gov	JPL	coronagraphs, occulters, system engineering	occulter and coronagraph
Lisse	Carey	Carey.Lisse@jhuapl.edu	JHU APL	exosystem spectroscopy / materials characterization	Science
Lo	Amy S	Amy.Lo@ngc.com	NGAS	Science measurements, DRMs, occulters, performance modeling, technology, ground testing	occulter
Mandell	Avi	Avi.Mandell@nasa.gov	NASA GSFC	IR spectral characterization of exoplanets	Science
Marley	Joe	joseph.h.catanzarite@jpl.nasa.gov	JPL	Science measurements, astrometry	Science
Marley	Mark	mark.s.marley@nasa.gov	NASA ARC	Planetary atmospheres and giant planet spectra	Science
McElwain	Michael	michael.w.mcelwain@nasa.gov	NASA GSFC	coronagraphy, wavefront control, and IFU spectroscopy and science policy	Science and technology
Noecker	Charley	mcnoecke@ball.com	Ball ATC	Science measurements, DRMs, coronagraphs, occulters, control systems, performance modeling, technology, ground testing	editor and co-chair, occulter and coronagraph, system engineering
Petit	Pascal	petit@ast.obs-mip.fr	Observatoire Mi	stellar magnetic activity via spectroscopy and spectropolarimetry	Science
Pitman	Joe	joe.pitman@exsci.org	ExSci	space telescopes, SE, modeling & simulation, I&T, verification	Strawman concepts and requirements
Postman	Marc	postman@stsci.edu	STScI	Large UV/O mission synergy	Large UV/O mission synergy
Redding	Dave	david.c.redding@jpl.nasa.gov	JPL	integrated modeling	system engineering
Roberge	Aki	aki.roberge-1@nasa.gov	NASA GSFC	Exozodi	Exozodi SAG lead
Serabyn	Gene	eserabyn@jpl.nasa.gov	JPL	Science, coronagraphs, interferometers	ultimate contrast, wavelengths, IWA
Shaklan	Stuart	stuart.b.shaklan@jpl.nasa.gov	JPL	architecture issues	occulter and coronagraph
Shao	Mike	michael.shao@jpl.nasa.gov	JPL	Planet / dust / speckle discrimination, astrometry, coronagraph (VNC)	Science and coronagraph
Smith	Erin C.	erin.c.smith@nasa.gov	NASA ARC	(Occulters)	occulter
Solmaz	Arif	arif.solmaz@gmail.com	Turkey (student)	Transits, exoplanets	
Soummer	Rémi	soummer@stsci.edu	STScI	Science measurements, coronagraphs, occulters	occulter and coronagraph
Sparks	Bill	sparks@stsci.edu	STScI	Biosignatures, circ. Polarization	Science, instrument concepts
Stapelfeldt	Karl	krs@exoplanet.jpl.nasa.gov	JPL	Science performance modeling, targets, dust	Science
Tanner	Angelle	angelle.tanner@gmail.com	Georgia State	target selection, astrometry, high contrast imaging	Science / targets
Tenerelli	Domenick	domenick.tenerelli@lmco.com	LMMSC	coronagraph and occulter missions and technologies	occulter and coronagraph
Trauger	John	John.Trauger@jpl.nasa.gov	JPL	coronagraph and wavefront control technologies	Mission design and performance simulations
Tsvetanov	Zlatan	zlatan@pha.jhu.edu	JHU	observations, science requirements, figures of merit	Science
Turnbull	Maggie	turnbull.maggie@gmail.com	Global Science	Target star characteristics, background objects	Science
Vanderbei	Robert	rvdb@Princeton.EDU	Princeton	Coronagraphs and Occulters	
Vosteen	Amir	amir.vosteen@tno.nl	TNO	nulling interferometry, systems engineering.	
Williams	Darren	dmw145@psu.edu	PSU	Earth-like moons of giant exoplanets	Science

Imaging SAG Progress

- Have met with the COPAG and agreed that we are both interested in trying to share a D >= 4-m telescope on an observatory that studies exoplanets and astrophysics
- Have chosen to focus on terrestrial planets (January ExoPAG meeting) with 4 – 8-m telescope. Importance of super-Earth and giant planets TBD
- We will work closely with SAG #4 in setting characterization requirements and with SAG #1 in exozodi requirements
- System of weighting and scoring different requirements proposed and exemplified for goal of deciding on mission architecture (C. Noecker)
- We have circulated a list of initial, preliminary requirements and have discussed them via email and during a telecon in May
- More telecons (and documents) are planned to focus on nailing down the requirements by early 2012. However, they will likely become obsolete due to future advances in science (e.g., eta_Earth, exozodi).

Preliminary Imaging SAG Requirements

Parameter	Baseline	Comment
Inner G2V HZ radius	0.7	Kasting definition
Outer G2V Hz radius	2	generous value
Min. # of HZs searched	30	TPF-C
Min. # of TXP orbits determined		??
Astrometric accuracy of orbits	10%?	Semi-major determination (added 5/23 telecon).
Mass determination precision (astrom	?	
Exozodi tolerance for TXP detections	3 zodis	TPF-C; TBR with SAG #1
Exozodi clumpiness tolerance	?	(added 5/23) ask SAG #1
Spectral features to be observed	H2O, CO2, O2	TPF-C; TBR w/SAG 4
Spectroscopic Resolution	70	TPF-C; TBR w/SAG 4
Min spect. Wavelength	0.5	microns; TPF-C; derived
Max spect wavelength	1.1	microns; TPF-C; derived
Angular resolution	50	mas; Telescope diffraction limit 1.0 microns
Photometric bands	3	TPF-C; TBR w/SAG 1 & 4
Photometric accuracy	10%	TPF-C TBR w/SAG 1 & 4
Photometric precision	10%	TPF-C TBR w/SAG 1 & 4
Mission lifetime	5	yrs TPF-C (possibly derived)
Giant planet requirements		? Are they planets too?
Disk science requirements		TBD with Disk / Exozodi SAG #1
Telescope FOV		TBD with COPAG

WAG – need Kepler η_{Earth}

WAG – need exozodi info

For Reference

SAG 7 Charter (January 2011 - obsolete)

1. Outline the science goals for the mission
   - Earths or bust, or are other planets OK?
   - What measurements needed: albedos? Atmospheric studies? Can TPF-C goals be met?
2. Describe the instrumentation
   - Contrast, wavelengths, sensitivity, spectral resolution, inner & outer working angles, spatial resolution --> Aperture, stability
3. Identify and characterize technology, engineering and verification challenges for the mission
   - What are tall poles? How much study & investment? When needed?
4. Create a Design Reference Mission (DRM)
   - What can be done over the mission life, what limitations?
   - Compare to TPF-C and more recent studies